American Water Works Association
2005 Membrane Technology Conference

Developing an Experimental Protocol for Evaluating Low-pressure Desalting Membranes for Seawater Desalination

Tai J. Tseng, Robert C. Cheng, Diem X. Vuong, and Kevin L. Wattier
Long Beach Water Department

March 7, 2005

Presentation Outline

- Long Beach Overview
- Research Background
- Research Goals/Approach
- Results
- Conclusion

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Long Beach Water Department

- California's 5th most populous city (480,000 people)
- 70,000 AF of drinking water per year
- 5,500 AF of reclaimed water per year
- Operate largest GW treatment plant in US
- 912 miles of drinking water lines
- 763 miles of sewer lines

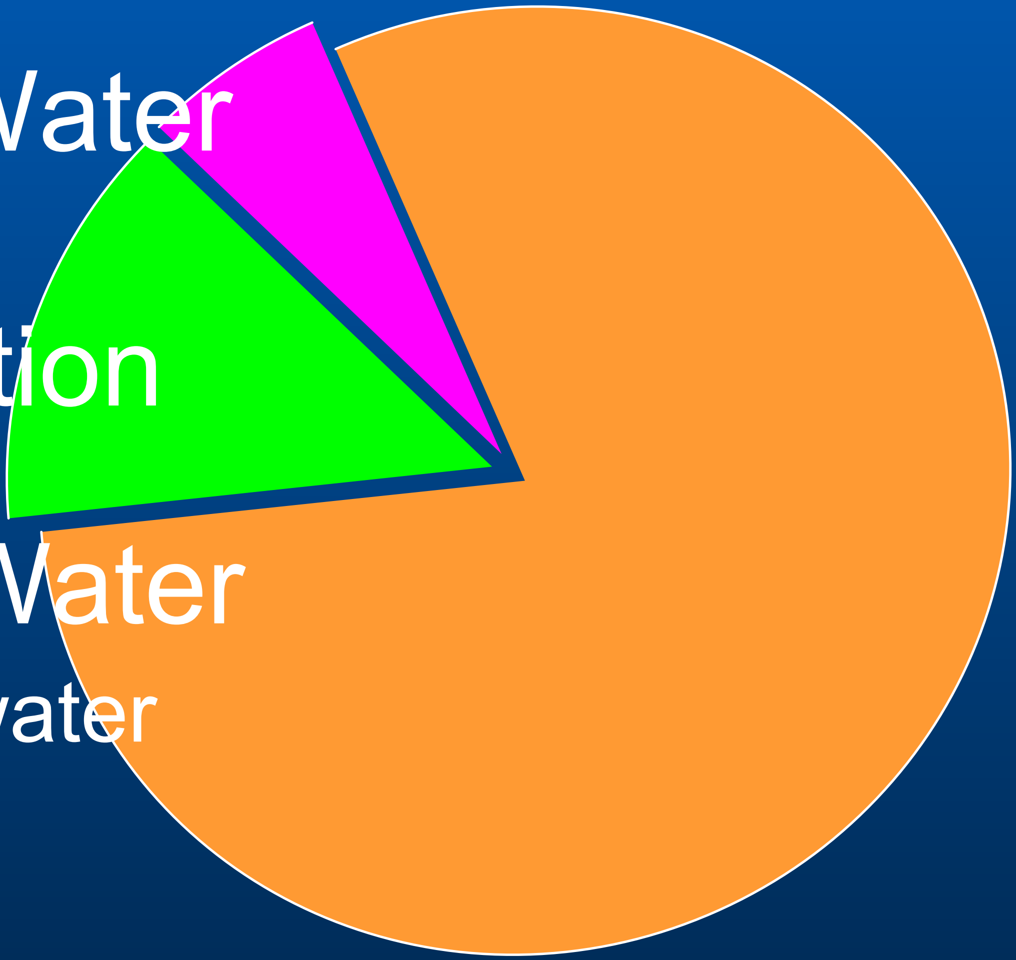
Long Beach Water Department

6%: Recycled Water

14%: Conservation

80%: Drinking Water

- -46% LB Groundwater
- -54% Imported



Imported Water Supply

Los Angeles Aqueduct:
~37% reduction

California Aqueduct:
~No Increase

Colorado River Aqueduct:
~50% reduction

…communities must produce more water locally to manage new limits on imports and growth in southern California's population and economy.

Future Reliability

- Very little population growth
- Expansion of recycled water and water conservation
- Seawater desalination necessary ==> supplement City's imported drinking water supply

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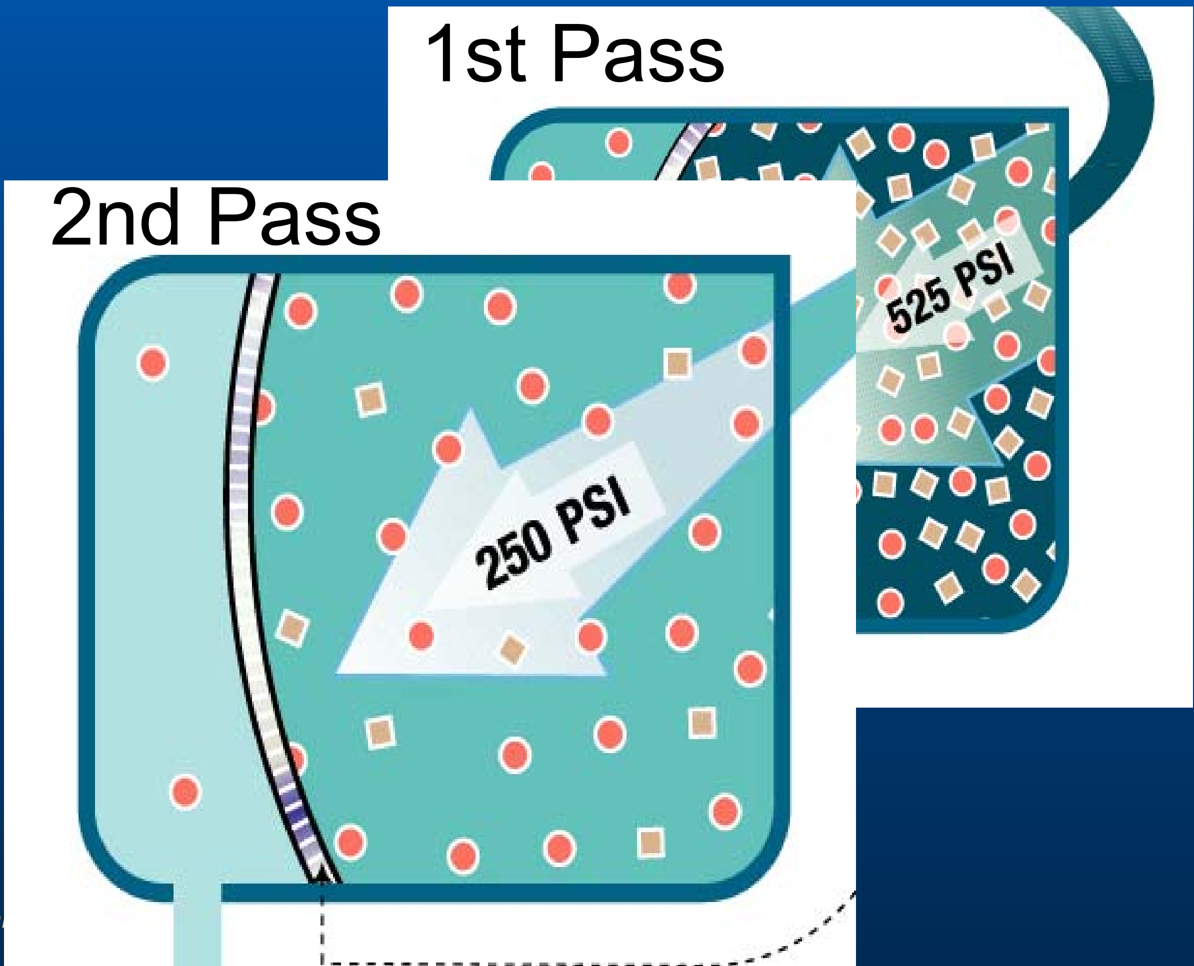
“Traditional” RO Process

- Uses pressures in excess of 800 psi
- Energy intensive
- High-pressure materials required $\Rightarrow$ high capital costs
- “Traditional” seawater desalination method cost prohibitive

Process Development

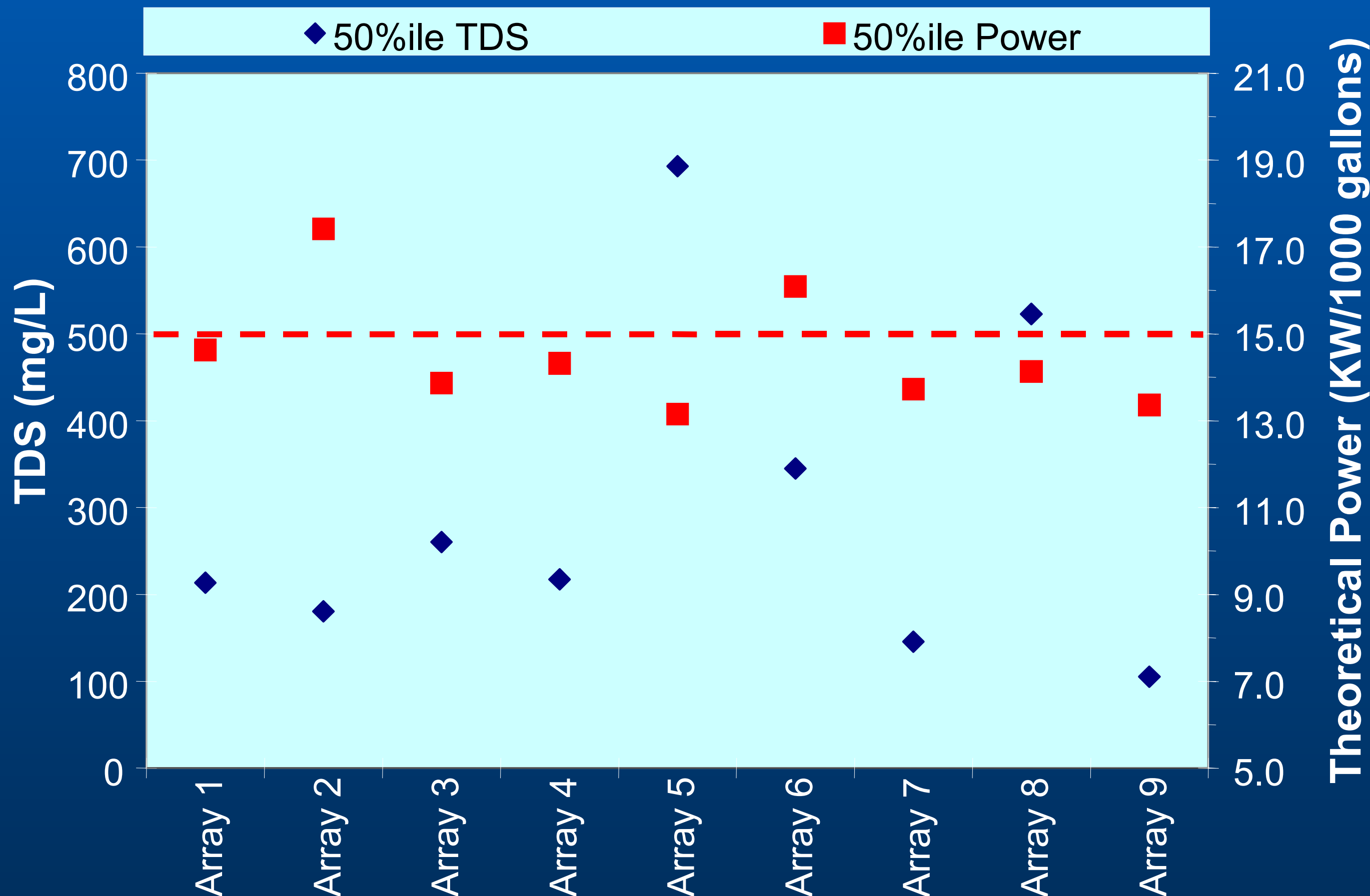
- Patent pending 2-pass Nanofiltration (NF^2) process



- 2 pass system provides some flexibility.
- 2 pass system provides two physical barriers.

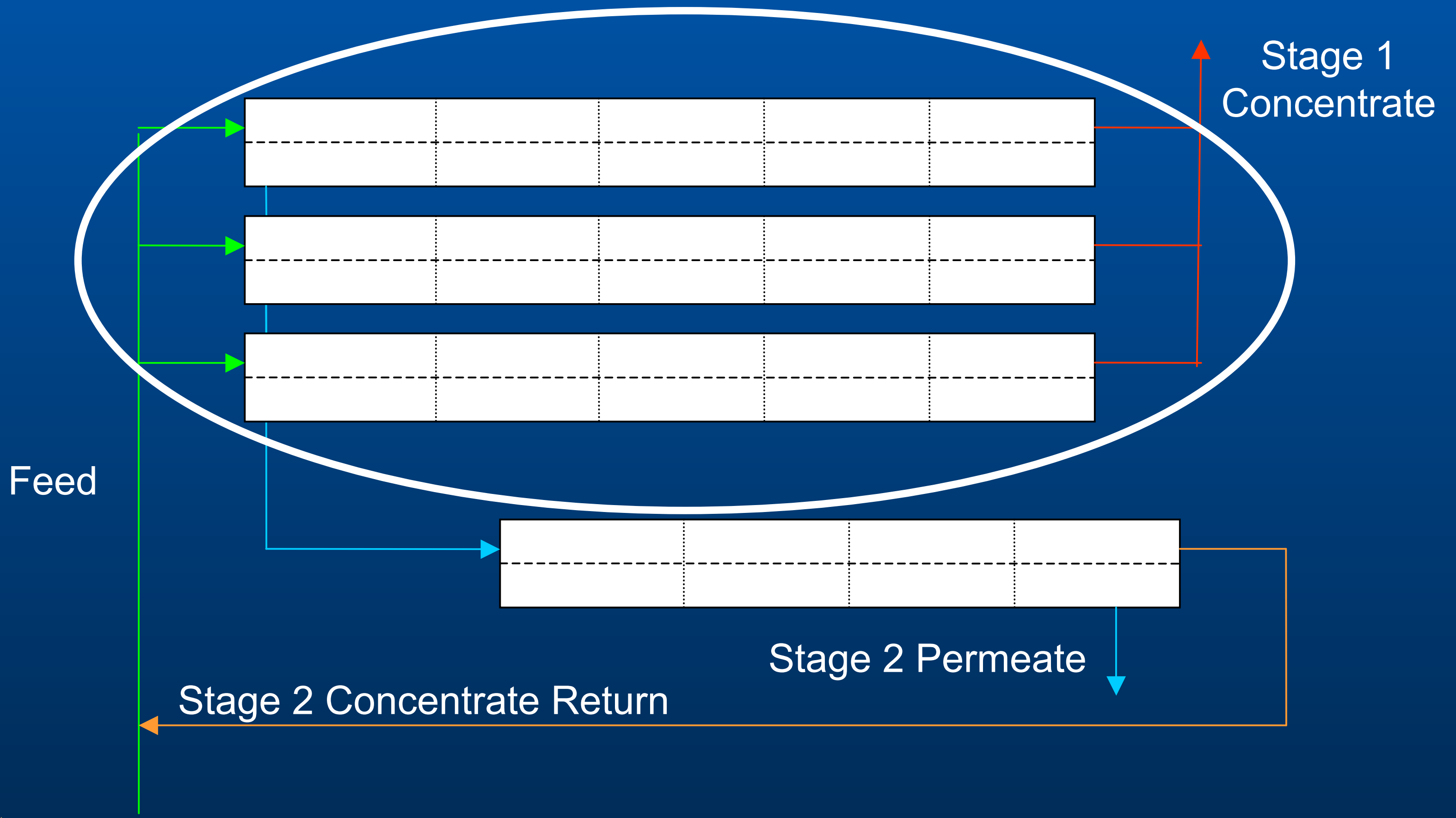
Preliminary Results

- Not a lot of literature. 15kW/kgal is the baseline.
- Early results showed calculated power vary from 17 to 13 kW/kgals



Optimization

Pass 1 pressure



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Research Goals/Approach

- Develop improved understanding of factors to optimize
- NF membrane performance as a function of:
  - Temperature
  - Pressure
  - Loading rate
- Develop a roadmap to membrane optimization and selection

Pilot Testing Equipment

- ~ 9000 gpd permeate pilot plant
- Pilot operates in closed loop
- 180,000 BTU chiller to maintain temperature

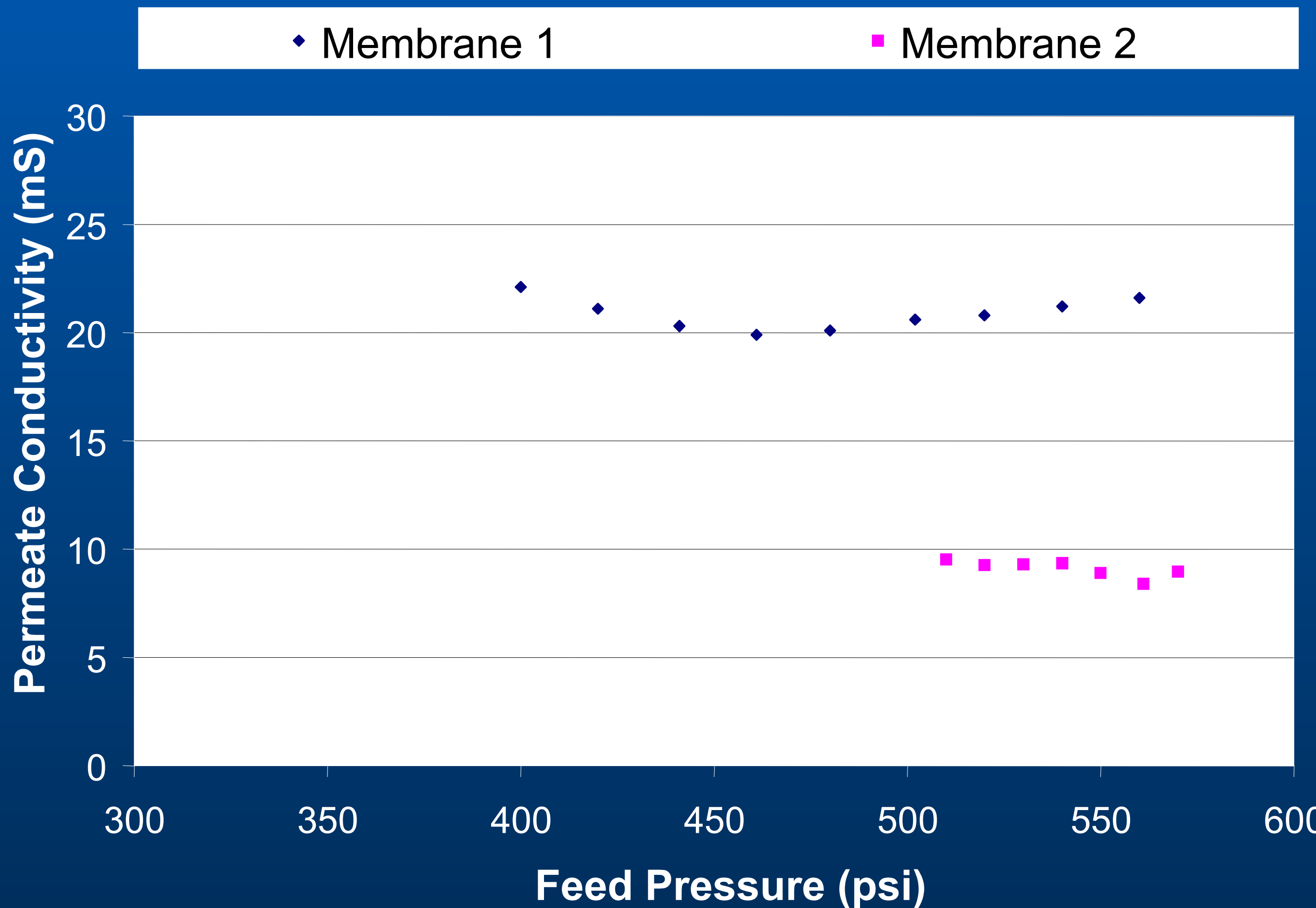
Membranes Tested

General Information					Manufacturer Test Condition				
Manufacturer	Model	Mat'l	Area (ft^2)	Product Flow (gpd)	$MgSO_4$		NaCl		Test P (psi)
					mg/L	Min. Rej.	mg/L	Min. Rej.	
FilmTec	NF90	PA	80	1,850	2,000	95.0%			70
Trisep	TS80	PA	81	2,000	2,000	97.0%			100
Trisep[1]	X20	PA	81	2,000			2,000	99.0%	100
Saehan	NE90	PA	85	1,900	2000	98.5%			75
Saehan[2]	NE90 V.2	PA	85						

- The membrane tested had relatively similar rejection characteristics

Membrane Performance

- Although manufacture specification were relatively similar, the water quality results can be significantly different



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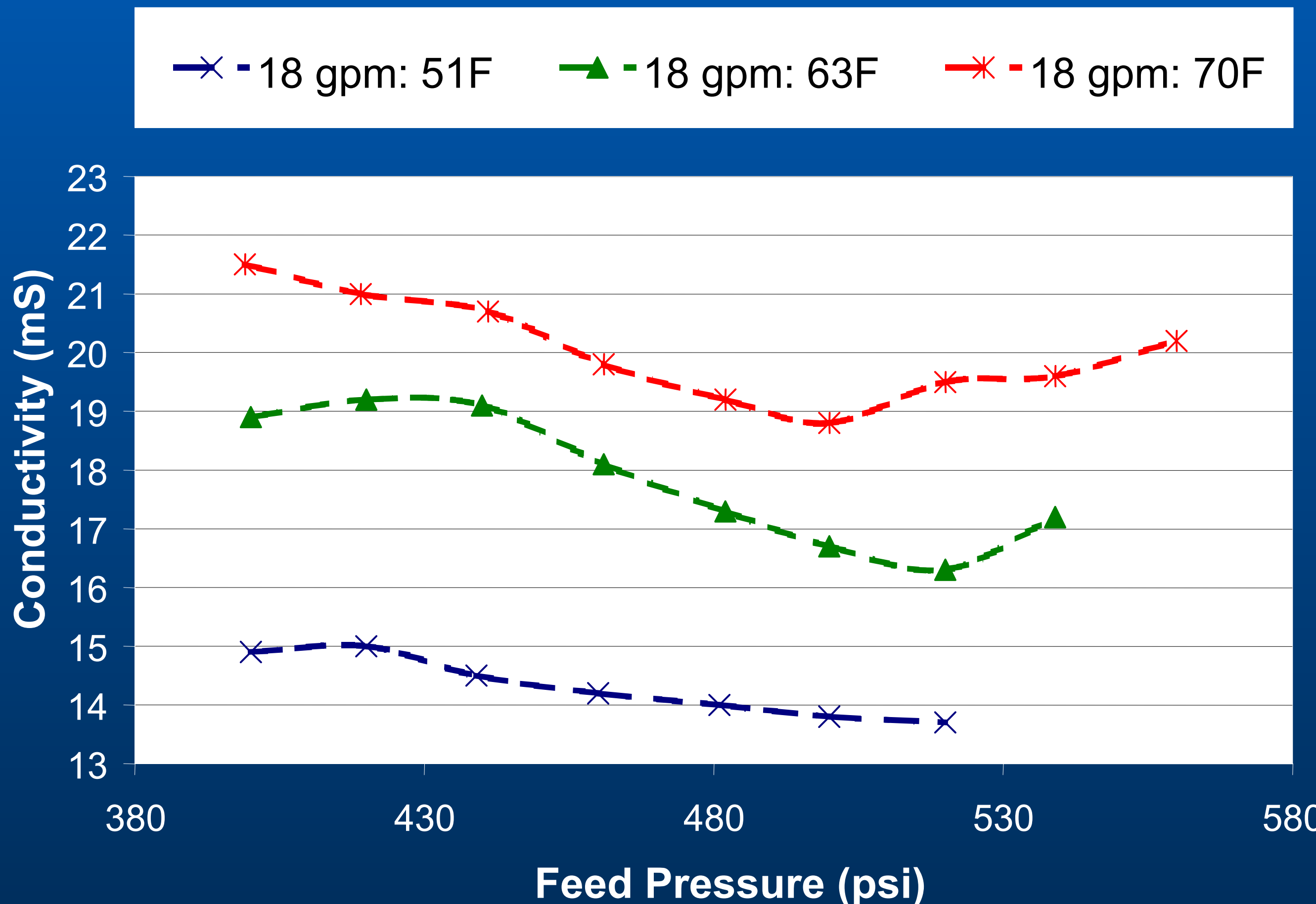
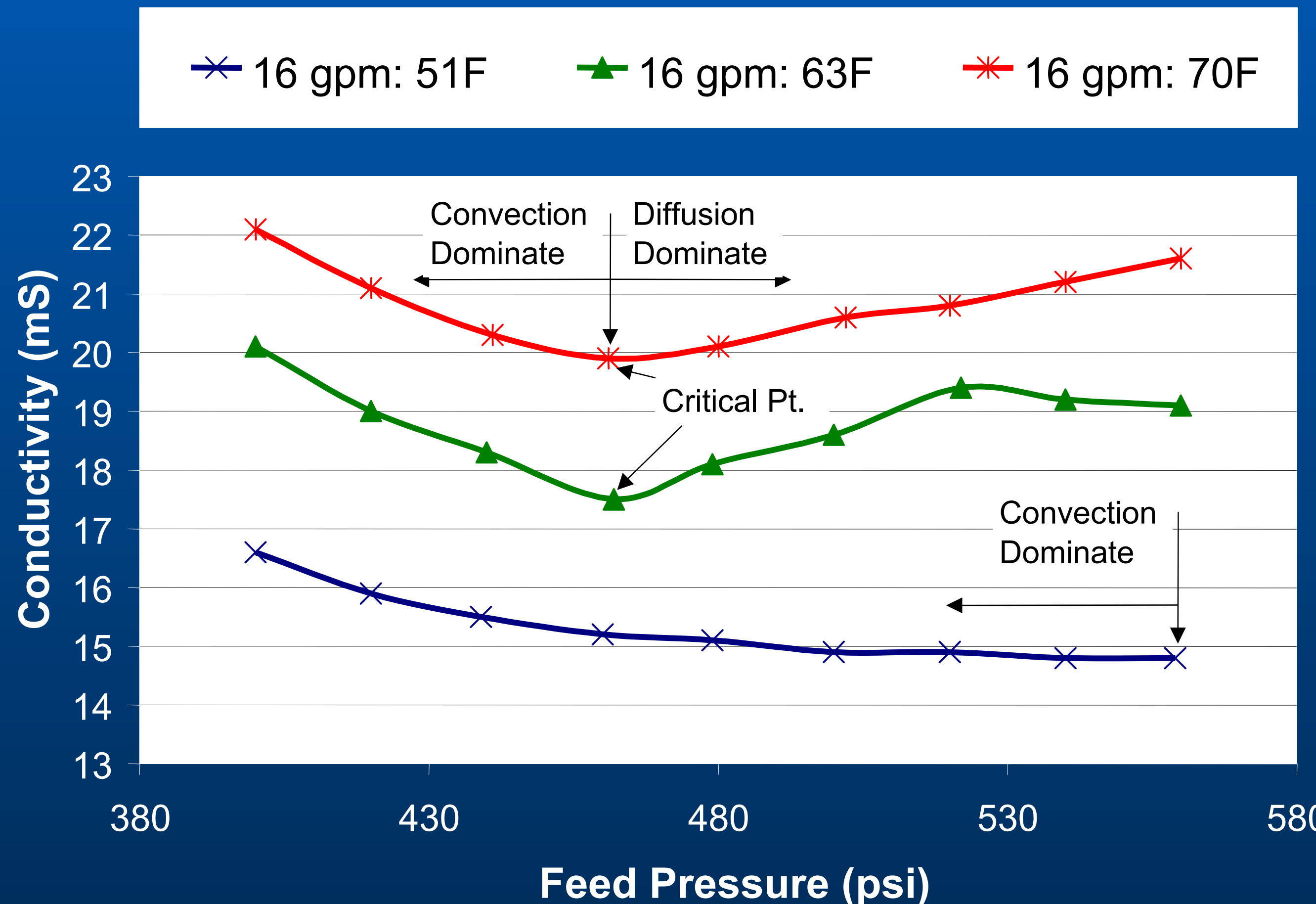
Results: Temperature

- At lower temperature, salt rejection improves.
- The is consistent with SWRO

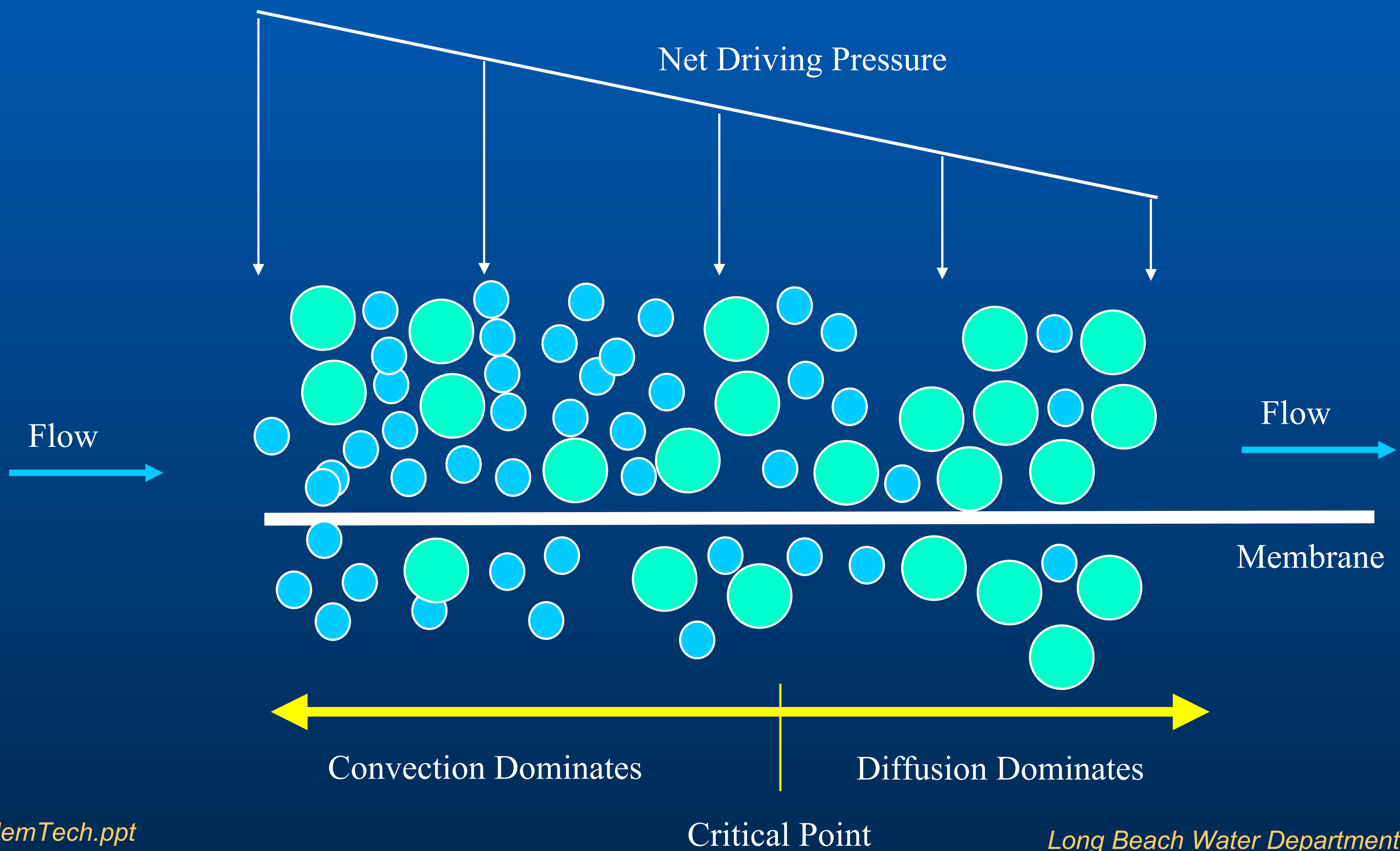


Results: Pressure

- At low temperature, membrane exhibit typical salt rejection behavior.
- However, a critical point develops at higher temperatures.

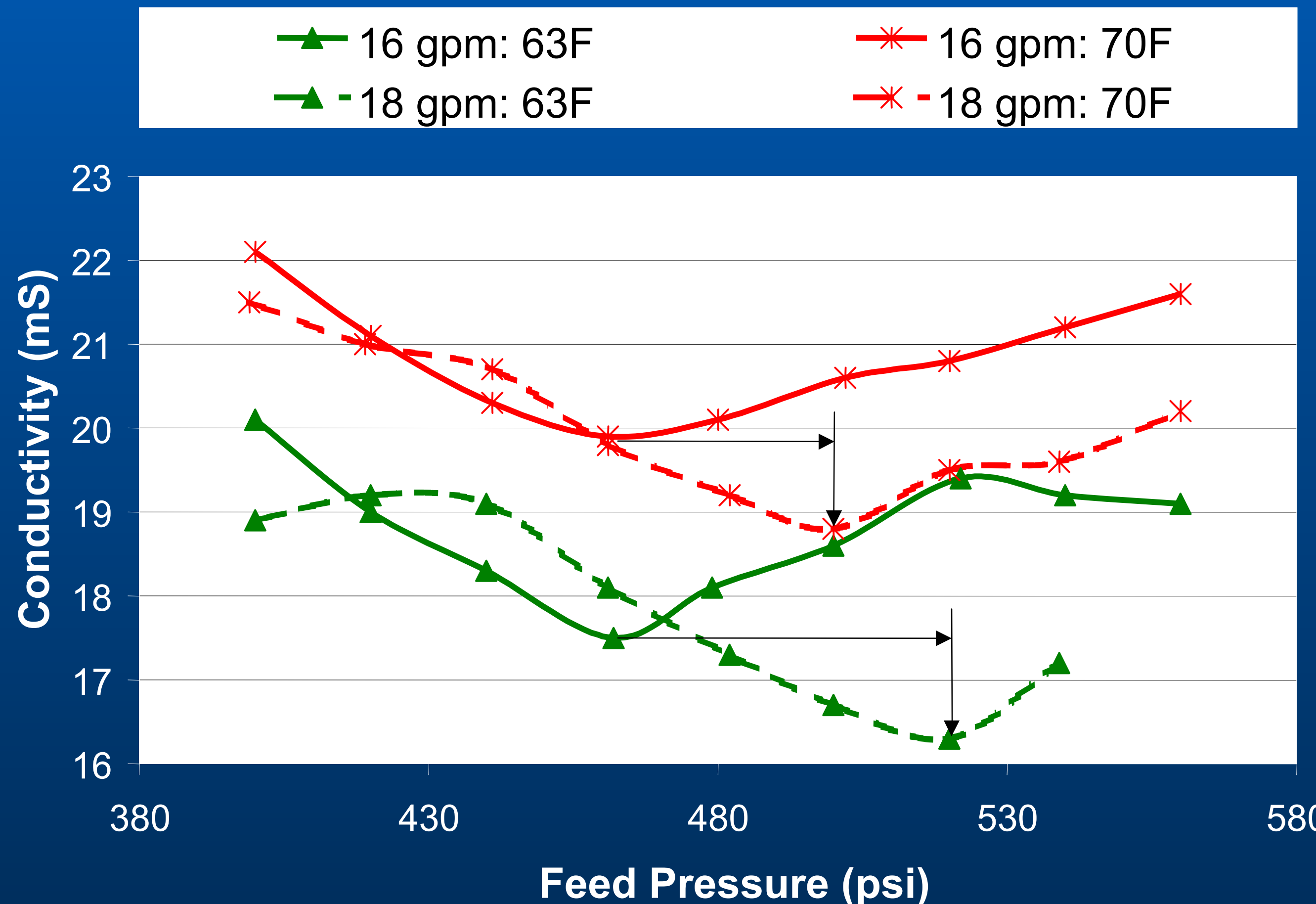


Results: Pressure

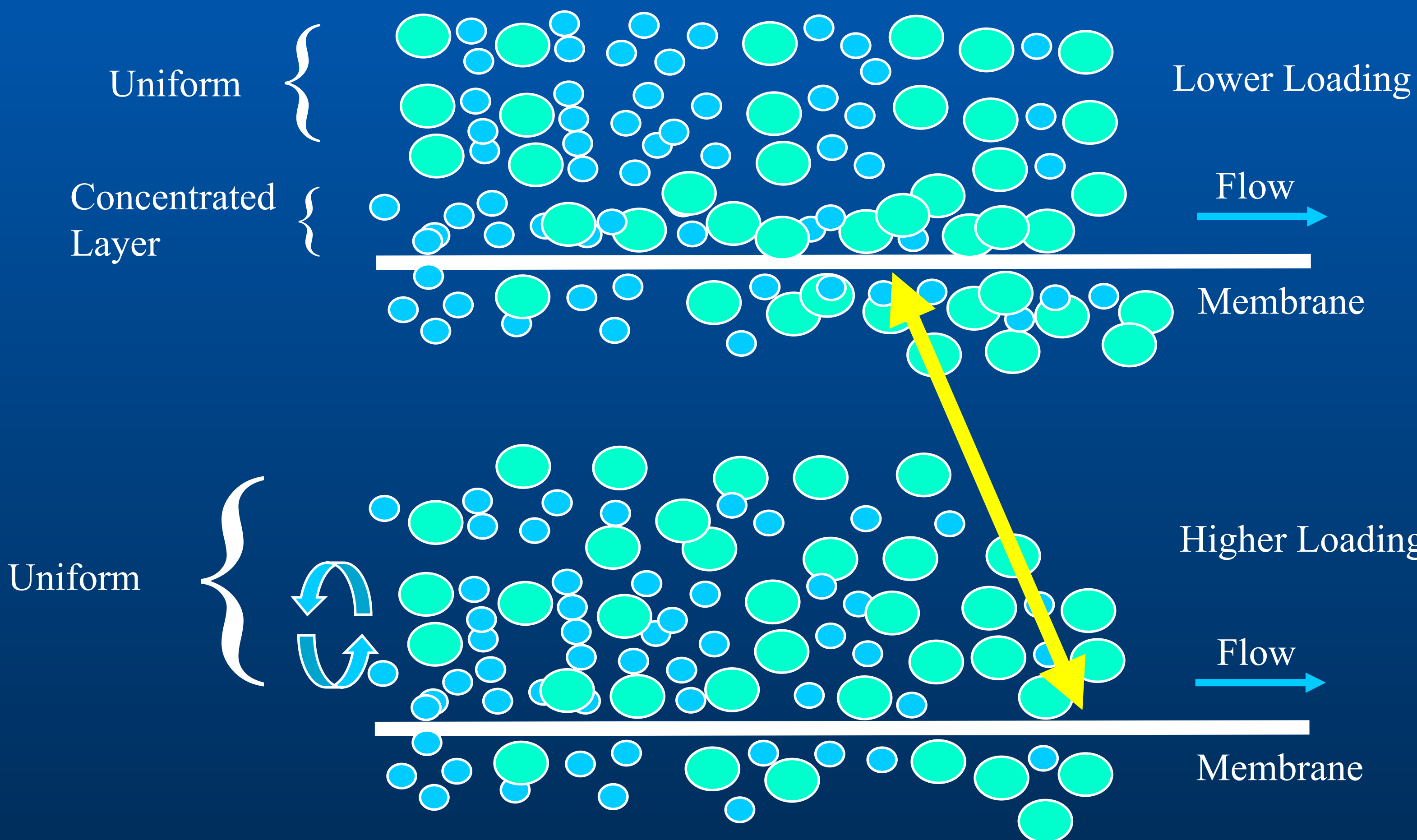


Results: Loading Rate

- Increasing loading rate will shift the critical point to the right.
- The shift allows higher pressures and better WQ.



Results: Loading Rate



Results: Roadmap

- The following will be the roadmap for our NF optimization:
  - Identify the critical point for each membrane.
  - Determine the optimal loading rate for the membrane.
  - Optimize pass 1 based on critical pt. and loading.
  - Optimize Pass 2 to achieve the desired WQ.
  - Determine the net operating energy under overall optimized conditions.
  - Determine optimal membrane operations for each membrane type and condition.

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Conclusions

- Lower pressure membranes can be used.
- Temperature behavior similar to SWRO.
- Each membrane will have a critical point.
- Higher loading rate is better.
- Optimization of critical point and loading rate.

Questions